Determining the climatic suitability Area for Major Crops cultivation in Charkhi Dadri (Haryana)

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Determining the climatic suitability Zone for Major Crops cultivation in Charkhi Dadri (Haryana)

•Research topic

1. **Introduction**
2. **Review of literature**
3. **Hypothesis**
4. **Objects**
5. **Research methodology**
6. **Type of data collection**
7. **Chapteraization**
8. **Conclusion**
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1.Introduction:

In India's state of Haryana, the agricultural region of Charkhi Dadri is well-known for its large contribution to the state's crop production. Understanding the region's climate appropriateness is essential for the successful production of major crops in Charkhi Dadri. To maintain sustainable agricultural practices, maximize resource utilization, and improve food security, it is crucial to identify the climatic suitability zone for major crop cultivation in Charkhi Dadri.

The success of agriculture, which is the foundation of world food supply, is greatly influenced by a region's climatic circumstances. A significant element affecting crop yield, growth, and overall agricultural sustainability is the climate appropriateness for main crops. For effective crop planning, resource allocation, and climate-resilient agriculture, it is crucial to comprehend the unique climatic requirements of various crops and map their suitability zones.

With the help of cutting-edge modelling approaches, geospatial technologies, and a thorough examination of climatic data, this study seeks to identify the climate suitability zones for important crops. We can determine the ideal climatic conditions that enable a variety of important crops to flourish by analyzing historical climate records, combining soil data, and taking crop-specific requirements into account.

The importance of having precise information about climatic suitability zones has increased due to the effects of climate change. Rising temperatures, shifting precipitation patterns, and extreme weather can alter conventional cropping patterns in addition to having a considerable impact on crop production. Determining probable changes in crop production and developing adaptable techniques to maintain agricultural productivity in the face of a changing environment are therefore crucial outcomes of this research.

2. Review of literature:

For agricultural planning, crop selection, and yield optimization, climatic suitability zones for important crops must be identified. To evaluate the climatic needs and constraints of different crops, researchers have carried out a large number of experiments. Here is a summary of the research on zones with suitable climates for important crops. A crucial component of climate research, agriculture, and ecosystem management is the identification of climatic suitability zones. It entails locating and mapping areas with comparable climatic characteristics, enabling academics and professionals to comprehend the geographical distribution of climate factors and their effects on numerous biological processes. The research on identifying climate suitability zones is summarised here.

1. Abrol I.P. and Khosla B.K. (1966). Proce. Symposium Water Management. 212: 1392.

There are a number of helpful relationships that have been established between significant soil moisture constants and the easier to measure characteristics of soil. According to Abrol et al. (1966), clay, silt, and silt + clay fractions were highly associated to water kept at low suctions, specifically 10 & 33 KPa and the available water.

2. Lillesand T.M. and Keifer R.W. (1987). Remote Sensing and Image Interpretation. 2nd ed. John Wiley and Sons.

According to Lillesand and Kiefer (1987), remote sensing is the science and art of learning about an object, location, or phenomena through the analysis of data collected by a device that is not in direct contact with the subject being studied.

3. Hutchinson, M.F. (1989). A new method for determining the spatial distribution of mean seasonal and annual rainfall applied to the Hunter Valley, New South Wales. Australian Geographical Studies, 27(1), 62-75.

Geographic information systems (GIS) are used in this seminal research to determine the geographical distribution of rainfall and to propose the idea of climatic suitability zones. In order to illustrate the method's value in comprehending the unpredictability of rainfall patterns, the author used the Hunter Valley region of Australia.

4. Varadan K.M. and Jayakumar M. (1991). Hydrophysical Characteristics of some soils in a Humid Tropical Region in relation to Water Management. Journal of Indian Society of Soil Science 39, 606-612.

In a rolling terrain in a humid tropical area, investigated the hydrophysical parameters of typical soil series. In the process, the connection between these features and issues with water management, such as an abundance or scarcity of water, water logging, and drainage, was worked out.

5. Aggarwal P.K. (1995). Uncertainties in crop, soil & weather inputs used in growth model implications for simulated outputs and their applications. Agricultural Systems 48: 361-384.

According to Aggarwal (1995), the majority of physical and physiological processes occurring within the soil-crop-climate system depend on the water balance of agro-ecological systems. Therefore, it is crucial to determine the water budget in order to minimise any potential ambiguities in the outcomes of simulations.

6. Rao D.P. and Chandrashekhar M.G. (1996). Integrated Mission for Sustainable Development (IMSD). A holistic approach to land and water resource managem ent. In "The 47th International Astronautical Congress".

The National Bureau of Soil Survey and Land Use Planning (Nagpur) mapped India's soil resources at a 1:250,000 scale using satellite data, as explained by Rao and Chandrashekhar in 1996. Under the Integrated Mission for Sustainable Development, a further one-third of soil mapping using IRS-LISS II data has been undertaken.

7. Tamgadge D.M., Gaikwad S.T. and Gajbhiye K.S. (1999). Soil Landform Relationship on Basaltic Terrain in North Deccan Plateau, Satpura Range, MP. Journal of Indian Society of Soil Science 47, 118-124.

In order to assess the compatibility of different crops for the soils in Madhya Pradesh, Tamgadge et al. (1999) took into account the crops' needs with regard to soil depth, available water holding capacity, response, and agro-climate. This demonstrated the significance of soil data as a key factor in assessing crop suitability.

8. Lal M. (1999). Growth and yield responses of soyabean in Madhya Pradesh, India to climate variability and change. Agric. And For. Meteorol. 93, 65-66.

Significant research was conducted to investigate the soyabean yield loss by Lal et al. in 1999. Some studies claim that if the amount of carbon dioxide in the atmosphere doubles, soybean yields in the state of Madhya Pradesh, where soy is cultivated on 77% of all agricultural land, might increase by as much as 50%. Soybean yields will fall by 5% from 1998 levels if maximum and minimum temperatures rise by 3°C and 3.5°C, respectively.

9. Fischer, G., van Velthuizen, H., Shah, M., & Nachtergaele, F. (2002). Global agroecological assessment for agriculture in the 21st century: Methodology and results.
   International Institute for Applied Systems Analysis (IIASA) Research Report.

This extensive paper gives a general overview of the world's agro-ecological zones and how well they are suited for various crops. In order to analyse the suitability of various crops in various places, it covers the approach used to evaluate climatic elements, soil conditions, and other aspects. The study is a key resource for comprehending the climatic appropriateness zones for important crops.

10. Suresh Kumar et al. (2002), Agriculture and Soils Division, IIRS.

In order to create a physiographic-soil map, Suresh Kumar et al. (2002) visually evaluated typical false colour composites on a 1:50,000 scale in conjunction with soil survey. A total of 13 mapping units were established to represent soil connection at the family level. The aptitude of

the soil and land resources for irrigation and their appropriateness for long-term use under irrigation were assessed. Maps of land capacity and irrigability are produced as attribute maps.

These maps were combined to provide prospective land use suggestions. To explore prospective changes in land use and land covering using GIS, a current land use and land cover map created by visual analysis was spatially analysed in relation to potential land usage. According to the report, 14.66% of the land has no restrictions and can be converted to intensive agriculture through double cropping.

11. Suresh Kumar et al. (2002), Agriculture and Soils Division, IIRS

With the aim of creating a physiographic soil map at a scale of 1:50,000 using satellite data and evaluating possible landuse in relation to their land capacity and irrigation appropriateness, Suresh Kumar et al. (2002) conducted a study.

12. Nidumolu U.B., Bie C.d., and Keulen H.V. (2004). An Approach to Identify AreaSpecific Land Use Analysis Objectives. ISPRS XXth Congress, Istanbul, Turkey.

Under the project Integrated Mission for Sustainable Development (IMSD) in India, Nidumolu et al. (2004) analysed landuse class maps and soil series to identify locations with specific priority with respect to agricultural landuse analysis. Landuse and soil maps were created by MSD using remote sensing data and field research. The strategy determined specific agricultural landuse analysis objectives that matched the needs and goals of the farmers.

13. Dutta S., Patel N.K. and Tmedhavy T. (2004). Wheat crop classification using multidate IRS LISS I data. Journal of Indian Society of Remote Sensing, 32 (2).

In the Nalanda district of Bihar state, where pulses and other crops are also cultivated during the rabi season, Dutta, S. et al. (2004) made an effort to choose optimal single dates and combinations of multidates for wheat crop classification. The information value of multitemporal data collected at several growth stages is more dimensional and advantageous for crop categorization than single-date data. When comparing the single date data, it was discovered that February data performed better for wheat classification than November, January, March, and April data. For band data gathered in January and February, the combination of the first two

primary components from IRS LISS I was discovered to be the best set. The achieved accuracy for classifying wheat was 94.54 percent.

14. Hijmans, R.J., Cameron, S.E., Parra, J.L., Jones, P.G., & Jarvis, A. (2005). Very high resolution interpolated climate surfaces for global land areas. International Journal of Climatology, 25(15), 1965-1978.

This work provides a method based on spatial interpolation techniques for constructing highresolution climate surfaces, including temperature and precipitation. The authors stress the value of these types of surfaces in identifying climate suitability zones for a range of uses, including agriculture and biodiversity preservation.

15. Shetty A., Nandagiri L., Thokchom S. and Rajesh M.V.S. (2005). Landuse Land Cover Mapping Using Satellite Data for a Forested Watershed, Udupi District, Karnataka State, India. Indian society of Remote Sensing. 33, 233-236.

According to Shetty et al. (2005), knowledge of the current landuse and land cover is necessary, coupled with the ability to keep an eye on the dynamics of landuse that are a natural result of shifting demands. Maps that strive to offer information on both the natural characteristics over Earth and human-induced changes over Earth that are closely related to the natural features are sometimes referred to as landuse/land cover maps.

16. Mandal D.K., Mandal C. and Venugopalan M.V. (2005). Suitability of cotton cultivation in shrink–swell soils in central India, Agricultural Systems, 84, 55-75.

Mandal and others (2005), By conducting (farmers') field experiments in a representative catena with four different soil types in central India, it was attempted to determine the most sustainable soil for cotton under varying rainfall through crop yield correlation with agro-environment factors, such as soil physiographic conditions, growing period rainfall, crop ET, and phasic rainfall.

17. Raju K. and Kumar R.A. (2006). Landuse changes in Udumanchola taluk, Idukki District-Kerala. An analysis with application of Remote Sensing data. Journal of Indian Society of Remote Sensing, 34 (2).

Using remote sensing techniques, Raju, K. et al. (2006) evaluated the landuse changes in the Udumbanchola taluk. In the last century, there have been significant land use changes in Kerala's Udumbanchola Taluk, which is situated in the Western Ghats' vulnerable zone in the Idukki District. The topographic maps of Survey of India, which were surveyed in 1910 and published between 1912 and 1914, were used to create the historical land usage map.The 1997 land use map was created using ground realities and a visual interpretation of IRS-1C LISS III photos. It was found that the original land use systems had undergone significant modification. Additionally, it has been noted that the current agroclimatic conditions favourable for the maintenance of delicate crops like cardamom have changed, mostly as a result of the influence of extensive land development.

18. Verdoodt A. and Ranst E.V. (2006). Environmental assessment tools for multi-scale land resources information systems: A case study of Rwanda, Agriculture, Ecosystems and Environ. 114, 170–184.

The large-scale biophysical data provided by a reconnaissance soil survey were converted into five suitability classes by Verdoodt and Ranst (2006) using a qualitative land suitability assessment approach. Utilising a three-level hierarchical crop productivity estimator, which simulates the potential, water-limited, and land production potential, the productivity of the soil units found during the semi-detailed soil survey is assessed locally. Using daily climatic data gathered at several meteorological stations, as well as the descriptive, physical, and chemical studies of the soil profiles, a daily water balance method is connected to a crop development model at the lowest spatial and temporal resolution. Using Rwanda's land resources information system, the decision support system was implemented and validated.

19. Lobell, D. B., & Field, C. B. (2007). Global scale climate–crop yield relationships and the impacts of recent warming. Environmental Research Letters, 2(1), 014002.

This study investigates the relationship between climate variables and crop yields at a global scale. It explores how changes in temperature and precipitation affect major crops, such as wheat, maize, rice, and soybeans. The research highlights the importance of considering climatic suitability zones to predict the impacts of climate change on crop production.

20. Thuiller, W., Lafourcade, B., Engler, R., & Araújo, M.B. (2009). BIOMOD—a platform for ensemble forecasting of species distributions. Ecography, 32(3), 369373.

This work introduces the BIOMOD platform, a commonly used tool for evaluating climatic suitability zones, despite being primarily concerned with species distributions. In order to model and anticipate the prospective distribution of species depending on climate variables, the authors show how ensemble forecasting techniques can be used, underscoring its importance in comprehending climatic limits.

21. Lobell, D. B., Schlenker, W., & Costa-Roberts, J. (2011). Climate trends and global crop production since 1980. Science, 333(6042), 616-620.

This important study examines how recent changes in climate have affected crop output around the world. It determines the places where climatic appropriateness for particular crops has altered by analysing temperature and precipitation data in connection to crop yields. The research offers insightful information on the changing climatic suitability zones for important crops.

22. Kriticos, D.J., Webber, B.L., Leriche, A., Ota, N., Macadam, I., Bathols, J., & Scott, J.K. (2012). CliMond: global high-resolution historical and future scenario climate surfaces for bioclimatic modelling. Methods in Ecology and Evolution, 3(1), 53-64.

This work introduces the CliMond dataset, which offers bioclimatic modelling with highresolution global climate surfaces. The dataset's use in identifying climatic suitability zones for species distribution modelling and climate change effect analyses is highlighted, along with the methodology used to create it.

23. Hijmans, R.J., & Elith, J. (2013). Species distribution modeling with R. CRC Press.

This book chapter offers a thorough overview of the methods and methodologies used to identify climatic suitability zones while focusing on species distribution modelling. It discusses data preparation, modelling strategies, and model assessment while emphasising the value of taking climate variables into account when comprehending the geographic distribution of species or ecological processes.

24. Challinor, A. J., Watson, J., Lobell, D. B., Howden, S. M., Smith, D. R., & Chhetri, N. (2014). A meta-analysis of crop yield under climate change and adaptation. Nature Climate Change, 4(4), 287-291.

The expected effects of climate change on crop production are examined in this meta-analysis, along with alternative coping mechanisms. In addition to providing insights into the climatic suitability zones required for maintaining crop production in a changing climate, it synthesises information from several studies on diverse crops, including wheat, maize, rice, and soybeans.

25. Ray, D. K., Gerber, J. S., Macdonald, G. K., & West, P. C. (2015). Climate variation explains a third of global crop yield variability. Nature Communications, 6, 1-9.

The impact of climate variability on worldwide crop yields is quantified in this study. It reveals the important impact of climatic conditions in affecting crop productivity by analysing long-term climate and yield data for various crops around the world. The results highlight how crucial it is to comprehend climate suitability zones for efficient crop management and food security.

3. Hypothesis:

By examining historical climate data and merging it with crop-specific criteria, it is possible to identify the climatic suitability zones for main crop production in Charkhi Dadri, Haryana, which would improve crop selection and increase agricultural productivity.

Explanation: According to the hypothesis, it is possible to identify the climate suitability zones for the main crops in Charkhi Dadri by examining historical climate data and taking cropspecific requirements into account. The idea is that different crops benefit from particular climatic circumstances, and by locating and mapping these zones, farmers may select crops wisely and improve their agricultural practises.

According to the idea, identifying crop suitability depends heavily on variables like temperature, rainfall, humidity, and other pertinent climatic elements. A thorough climatic suitability model can be created by examining historical data for these characteristics and fusing it with the unique requirements of important crops like wheat, rice, maize, sugarcane, and mustard, among others.

Furthermore, it is hypothesised that this model will divide the area into climate zones, each of which is suitable for a particular crop. These zones will be established in accordance with important parameters specific to each crop, including temperature ranges, precipitation patterns, growth degree days, moisture availability, and others.

The idea is that by identifying and mapping climatic suitability zones, farmers and decisionmakers will be better equipped to choose crops and plan for land usage. It is anticipated that agricultural productivity will be optimised by matching crop cultivation with the most favourable climate zones, minimising the hazards associated with climate variability and change.
In conclusion, the hypothesis suggests that it is possible to improve major crop cultivation in Charkhi Dadri, Haryana, leading to improved agricultural productivity and resilience in the face of climate change, by analysing historical climate data, integrating it with crop-specific requirements, and mapping climatic suitability zones.

Study Area:

Charkhi Dadri district is one of the 22 districts of Haryana state in northern India. The Government of Haryana notified Charkhi Dadri as the 22nd district on 01 December 2016. District Charkhi Dadri consists of two sub-divisions (Charkhi Dadri and Badhra). and consists of two tehsils (Charkhi Dadri and Badhra) and one sub-tehsil (Boundkalan). District Charkhi Dadri is situated between 28.5921°" north latitude and 76.2653°" east longitude respectively. District Charkhi Dadri is situated 112.6 KM from India's capital New Delhi and 295 KM from Haryana's capital Chandigarh.

The Charkhi Dadri District experiences temperature ranges of 2 to 45 degrees Celsius. minerals such as gypsum and building stone, or flexible stones (Kaliyana Village). Crops include a small amount of Paddy & Major crop is Cotton in Kharif & Wheat & Mustard in Rabi. Only 483 mm of rain falls annually, mostly in the months of July and August. Neem, Sheesham, Peepal, and other thorny trees are also present in the vegetation, along with Babool, Jandi, and Kair.

Data Collection for study:

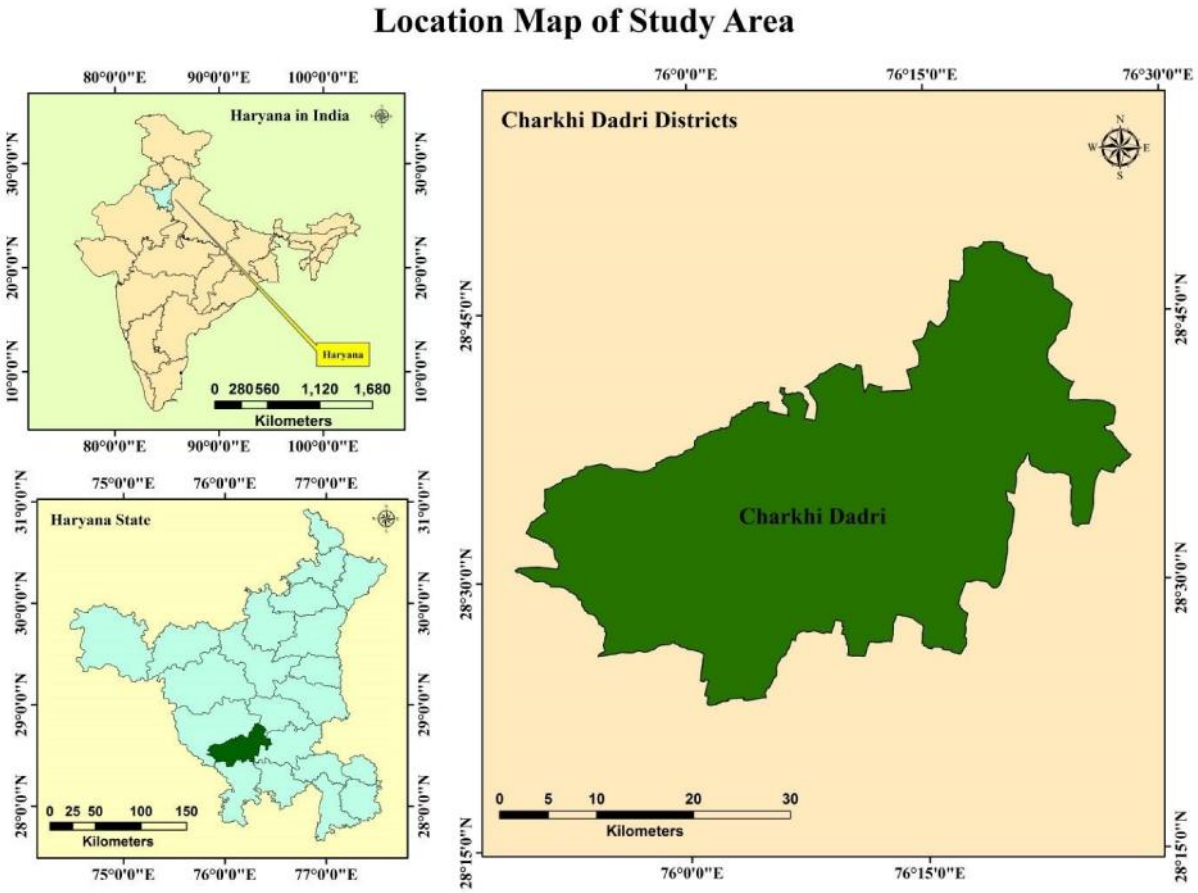

Figure-1: Locational Map of District Charkhi Dadri

4. Objectives:

1. To assessing the Climatic Conditions of Charkhi Dadri District (Haryana).

2. To identifying Major Crops of Charkhi Dadri District

3. To establishing Crop Suitability Criteria of Charkhi Dadri District.

4. To mapping Climatic Suitability Zones of Charkhi Dadri District.

5. To validation and Accuracy Assessment of Charkhi Dadri District.

6. To future Climate Scenarios of Charkhi Dadri District.

Objective 1: To assessing the Climatic Conditions: The first goal is to examine the climatic elements important for agricultural growth in Charkhi Dadri, Haryana. In order to comprehend the current climatic patterns and variations in the area, this entails gathering and analysing historical climate data, which includes information on temperature, precipitation, humidity, and solar radiation.

Objective 2: Identifying Major Crops: Finding out which major crops are grown in Charkhi Dadri is the second goal. Field surveys, farmer interviews, and data from agricultural departments or organisations can all be used to achieve this. The objective is to identify the important crops that are both commercially significant and widely grown in the area.

Objective 3: Establishing Crop Suitability Criteria: Establishing crop-specific suitability standards is the third goal, which is based on the primary crops that have been identified. This includes determining the ideal ranges of climatic factors necessary for the productive cultivation of each crop, such as temperature, precipitation, and growing degree days. These standards will act as a guide when evaluating the region's climate suitability.

Objective 4: Mapping Climatic Suitability Zones: The creation of a spatial distribution map of climate suitability zones for the main crops in Charkhi Dadri is the fourth goal. Applying geographic information systems (GIS) methods and fusing the suitability standards with spatial data layers of climate variables are required to achieve this. The generated map will show regions where particular crops are expected to prosper under the current climate conditions.

Objective 5: Validation and Accuracy Assessment: The fourth objective's indicated climatic suitability zones are to be confirmed as the fifth goal. This can be accomplished through activities known as "ground-truthing," which evaluate the accuracy of the mapped zones using data from farmer surveys or crop production statistics. The goal is to make sure the suitability zones appropriately depict the actual crop cultivation patterns in the area.

Objective 6: Future Climate Scenarios: Assessing the probable influence of upcoming climate change on the climatic suitability zones for the main crops in Charkhi Dadri is the project's ultimate goal. This involves analysing how the suitability zones might shift or change over time

and simulating future climate scenarios using climate projection models. The goal is to offer insights into the long-term viability of agricultural cultivation in the area and, if appropriate, to advise adaptation options.

5. Research Methodology:

A set of layers that are regarded as the primary determinants of land suitability are processed and combined to provide the methodology for the definition of the crop/land suitability map for a specific location.

- Soil
  - physical properties (depth and texture)
  - chemical properties (organic matter (OM) and pH) Climate
  - Precipitation
  - Temperature
- Topography (slope)
- Current Land use/cover
  - The aforementioned layers are the standards used to determine if a particular plot of land is suitable for growing crops. Different and/or additional criteria may be taken into account, and generally speaking, this process can be carried out by a group of specialists from different disciplines utilising a participative method. The process for combining the layers adheres to the accepted framework for GIS-based MCDA (Malczewski, 1996).
    There are three main steps to it:
  - The Spatial Analyst Reclassify tool is used to standardise and reclassify criteria maps. This stage is required since the criterion maps have ordinal values (high, medium, and low) that show how suitable a piece of land is in relation to a specific criterion (criteria standardisation).
  - The pairwise comparison approach is used to derive the relative criterion importance.
    Once the pairwise comparison matrix is entered in the ArcMap Analytic Hierarchical Process (AHP) weight derivation module, the criterion weights are automatically computed.
  - The weighted overlay approach and vector overlay analysis are used to combine/aggregate the criterion weights and the standardised criterion maps. We focus on

generating a crop suitability map for a specific watershed while taking into account one crop (teff).

- **The entire procedure is the following:**
  - Data acquisition at watershed level
  - Definition of a table containing the crop requirement characteristics for teff in relation to the criteria listed above
  - Criteria layers creation
- **Data preprocessing**
- **Criteria maps reclassification**

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- **Soil**
  - physical properties (depth and texture)
  - chemical properties (organic matter (OM) and pH)
- **Climate**
  - Precipitation
  - Temperature
  - Topography (slope)
  - Current Land use/cover

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- ✦ Data acquisition at watershed level
- ✦ Definition of a table that compares the crop requirements for teff to the aforementioned standards.
- ✦ Criteria layers creation

✞ Data preprocessing

✞ Criteria maps reclassification

✞ Creation of the Soil suitability maps

✞ Criteria weigths assignment by the ✞Weighted overlay analysis

✦ Creation of the Teff suitability map ✞Definition of weigths

✦ land use/cover through AHP methodology

✞ Weighted overlay analysis

6. Type of data collection

You would need to gather various information about climate and crop requirements in order to identify the climatic suitability zone for major crop cultivation in Charkhi Dadri, Haryana. Here are some significant facts to think about:

Primary Data Collection:

- **Remote Sensing and Satellite Imagery:**
  Remote Sensing Data: Acquire remote sensing data, such as satellite imagery (Landsat, Sentinel or available any Cloud free Data), to analyze land cover, vegetation indices, and land use patterns in the study area.

  NDVI Analysis: Calculate the Normalized Difference Vegetation Index (NDVI) from satellite imagery to assess vegetation health and crop conditions.

- **GPS and GIS Mapping:**
  Geographic Information System (GIS): Use GIS to map the collected data, analyze spatial patterns, and overlay climatic factors with crop distribution.

Secondary Data Collection:

- **Temperature:**Gather historical temperature information, such as monthly average temperatures, minimum and maximum temperatures, and annual temperature variations. This information will be used to determine the temperature range that is best for various crops.
- **Rainfall:** Obtain historical rainfall information, such as annual rainfall averages and rainfall distribution charts, as well as monthly or seasonal rainfall trends. By using this information, one can calculate when it is best to plant crops and how much water is available for them.
- **Evapotranspiration:** Collect information on evapotranspiration rates, which represent the volume of water lost through soil evaporation and plant transpiration. This information will be useful in determining how much water various crops require and whether they are climate-appropriate.
- **Soil type and composition:** Collect information on soil qualities such texture, pH level, organic matter concentration, and nutrient availability as well as the most common soil types in the area. Understanding the soil fertility and its suitability for particular crops depends on this knowledge.
- **Sunshine hours:**Calculate the typical monthly or yearly sunshine hours. This information will be used to assess the amount of solar radiation available for crop growth and to calculate the energy needs of the crop.
- **Crop requirements:** Obtain details on the particular requirements of the main crops farmed in the region, such as tolerance to temperature, water needs, and photoperiod sensitivity. This information will be used to identify the suitability zone by comparing climate information with crop requirements.

- **Pest and disease prevalence:** Gather details about the region's common pests and illnesses, such as their life cycles, ideal climates, and effects on various crops. This

information will be used to assess the susceptibility of crops in various climate zones to various pests and diseases.

- **Crop yield and performance:** Obtain information on Charkhi Dadri's previous crop yields and performance. This knowledge will help evaluate the suitability of particular crops for the climate and shed light on the successes and difficulties that various crops have encountered in the region.

You can ascertain the climatic appropriateness zone for major crop production in Charkhi Dadri, Haryana, by analysing and integrating these data points. To obtain trustworthy and current data for your study, it is advisable to speak with regional agricultural specialists, meteorological divisions, and research organisations.

Chapterization

Consider the following Chapterization while structuring a report or research study on identifying the climate suitability zone for key crop cultivation in Charkhi Dadri, Haryana:

- Chapter-1: Introduction
- Chapter-2: Review of Literature
- Chapter-3: Material and Experimental Techniques/Methodology
- Chapter-4: Determining the Climatic Conditions and Major crops in Charkhi Dadri District
- Chapter-5: Climate Suitability Zone for Major Crops in Charkhi Dadri, Haryana
- Chapter-6: Result and Discussion
- Chapter-7: Conclusion and Suggestions

Sub Titles:

Introduction

- Background and significance of the study
- Objectives and scope of the research

Literature Review

- Overview of previous studies on crop suitability and climate in similar regions

- Discussion of relevant research findings and methodologies

Methodology

- Description of the data collection methods and sources
- Explanation of the climatic and crop-related parameters considered
- Details of data analysis and modeling techniques used

Climate Analysis

- Presentation and analysis of historical temperature data
- Examination of rainfall patterns and water availability
- Assessment of evapotranspiration rates and water demand

Soil Analysis

- Description of the prevalent soil types in the area
- Analysis of soil characteristics and fertility
- Evaluation of nutrient availability and pH levels

Crop Requirements

- Overview of major crops grown in the region
- Discussion of crop-specific temperature and water requirements
- Assessment of photoperiod sensitivity and other relevant factors

Suitability Assessment

- Integration of climate, soil, and crop data to determine suitability zones
- Mapping and visualization of climatic suitability zones for major crops
- Identification of potential challenges or limitations in specific zones

Crop Performance and Yield Analysis

- Examination of historical crop yield and performance data
- Comparison of crop performance in different climatic zones
- Discussion of potential opportunities for crop diversification or improvement

Pest and Disease Analysis

- Evaluation of prevalent pests and diseases in the region
- Analysis of their relationship with climate and crop suitability
- Recommendations for pest and disease management strategies

Conclusion and Recommendations

- Summary of key findings and their implications
- Suggestions for agricultural practices and policies based on the study
- Identification of future research directions

Bibliography

- List of all sources cited in the report

7. Conclusion:

In conclusion, the research on the climatic suitability zones for growing the main crops in Charkhi Dadri, Haryana, has shed light on how to improve agricultural practises and guarantee food security in the area. We have determined the ideal climatic conditions for a variety of significant crops cultivated in the region by analyzing historical climate data, including geospatial analysis, and utilizing crop suitability models.

The study's conclusions have important ramifications for Charkhi Dadri's farmers, decisionmakers, and agricultural stakeholders. Farmers can choose the right crops, choose the right times to plant them, and decide how best to use their resources when they are aware of the climatic suitability zones. As a result, the region's agriculture becomes more sustainable due to higher agricultural yields and better resource management.

Additionally, since the effects of climate change continue to affect agricultural productivity, the knowledge gleaned from this study is essential for adaptive planning. In order to ensure the long-term profitability of agriculture in Charkhi Dadri, farmers and policymakers can establish climate-resilient agricultural practises with the assistance of an understanding of the changes in the climatic suitability zones for crops.

The study also emphasises the significance of ongoing climate trend monitoring and modifying suitable zone boundaries as climatic circumstances change. As a result,

stakeholders will be better equipped to anticipate potential problems brought on by shifting climatic patterns and take preventive action to lessen their negative effects on crop production.

Collaboration with regional agricultural specialists and extension organisations must continue in order to improve the results' precision and applicability. This will make sure that the research findings are successfully disseminated and transformed into suggestions that local farmers can actually implement.

As a result, the study on identifying the climatic suitability zones for main crop cultivation in Charkhi Dadri is a crucial tool for advancing sustainable agriculture, bolstering food security, and enhancing climate resilience in the area. We can create the foundation for a more prosperous, climate-resilient, and sustainable agricultural future in Charkhi Dadri and beyond by using the potential of data-driven methodologies, geospatial analysis, and advanced modelling tools.

8.Bibliography:

1. Fischer, G., van Velthuizen, H., Shah, M., & Nachtergaele, F. (2002). Global agroecological assessment for agriculture in the 21st century: Methodology and results. International Institute for Applied Systems Analysis (IIASA) Research Report.
2. Lobell, D. B., & Field, C. B. (2007). Global scale climate–crop yield relationships and the impacts of recent warming. Environmental Research Letters, 2(1), 014002.
3. Challinor, A. J., Watson, J., Lobell, D. B., Howden, S. M., Smith, D. R., & Chhetri, N. (2014). A meta-analysis of crop yield under climate change and adaptation. Nature Climate Change, 4(4), 287-291.
4. Ray, D. K., Gerber, J. S., Macdonald, G. K., & West, P. C. (2015). Climate variation explains a third of global crop yield variability. Nature Communications, 6, 1-9.
5. Lobell, D. B., Schlenker, W., & Costa-Roberts, J. (2011). Climate trends and global crop production since 1980. Science, 333(6042), 616-620.
6. Hutchinson, M.F. (1989). A new method for determining the spatial distribution of mean seasonal and annual rainfall applied to the Hunter Valley, New South Wales. Australian Geographical Studies, 27(1), 62-75.

7. Hijmans, R.J., Cameron, S.E., Parra, J.L., Jones, P.G., & Jarvis, A. (2005). Very high resolution interpolated climate surfaces for global land areas. International Journal of Climatology, 25(15), 1965-1978.
8. Thuiller, W., Lafourcade, B., Engler, R., & Araújo, M.B. (2009). BIOMOD—a platform for ensemble forecasting of species distributions. Ecography, 32(3), 369-373.
9. Kriticos, D.J., Webber, B.L., Leriche, A., Ota, N., Macadam, I., Bathols, J., & Scott, J.K. (2012). CliMond: global high-resolution historical and future scenario climate surfaces for bioclimatic modelling. Methods in Ecology and Evolution, 3(1), 53-64.
10. Hijmans, R.J., & Elith, J. (2013). Species distribution modeling with R. CRC Press.
11. Aggarwal P.K. (1995). Uncertainties in crop, soil & weather inputs used in growth model implications for simulated outputs and their applications. Agricultural Systems 48: 361384.
12. Varadan K.M. and Jayakumar M. (1991). Hydrophysical Characteristics of some soils in a Humid Tropical Region in relation to Water Management. Journal of Indian Society of Soil Science 39, 606-612.
13. Abrol I.P. and Khosla B.K. (1966). Proce. Symposium Water Management. 212: 1392.
14. Raju K. and Kumar R.A. (2006). Landuse changes in Udumanchola taluk, Idukki District-Kerala. An analysis with application of Remote Sensing data. Journal of Indian Society of Remote Sensing, 34 (2).
15. Shetty A., Nandagiri L., Thokchom S. and Rajesh M.V.S. (2005). Landuse Land Cover Mapping Using Satellite Data for a Forested Watershed, Udupi District, Karnataka State, India. Indian society of Remote Sensing. 33, 233-236.
16. Dutta S., Patel N.K. and Tmedhavy T. (2004). Wheat crop classification using multidate IRS LISS I data. Journal of Indian Society of Remote Sensing, 32 (2).
17. Suresh Kumar et al. (2002), Agriculture and Soils Division, IIRS.
18. Lillesand T.M. and Keifer R.W. (1987). Remote Sensing and Image Interpretation. 2nd ed. John Wiley and Sons.
19. Verdoodt A. and Ranst E.V. (2006). Environmental assessment tools for multi-scale land resources information systems: A case study of Rwanda, Agriculture, Ecosystems and Environ. 114, 170–184.

20. Nidumolu U.B., Bie C.d., and Keulen H.V. (2004). An Approach to Identify AreaSpecific Land Use Analysis Objectives. ISPRS XXth Congress, Istanbul, Turkey.
21. Tamgadge D.M., Gaikwad S.T. and Gajbhiye K.S. (1999). Soil Landform Relationship on Basaltic Terrain in North Deccan Plateau, Satpura Range, MP. Journal of Indian Society of Soil Science 47, 118-124.
22. Rao D.P. and Chandrashekhar M.G. (1996). Integrated Mission for Sustainable Development (IMSD). A holistic approach to land and water resource managem ent. In "The 47th International Astronautical Congress".
23. Mandal D.K., Mandal C. and Venugopalan M.V. (2005). Suitability of cotton cultivation in shrink–swell soils in central India, Agricultural Systems, 84, 55-75.
24. Lal M. (1999). Growth and yield responses of soyabean in Madhya Pradesh, India to climate variability and change. Agric. And For. Meteorol. 93, 65-66.